# UNCOATED PAPER HAVING A PSEUDO-WATERMARK AND METHOD OF MANUFACTURING THE SAME

The present invention relates to an uncoated paper having at least one pseudo-watermark, consisting of a mark which provides the paper with a visual effect and a texture resembling that of a watermark.

The present invention also relates to a method of manufacturing an uncoated paper according to the invention.

Watermarked papers are generally used in the field of security papers, such as payment means, including bank notes, checks and letters of credit; and official documents, such as passports, identity cards, stamped paper; and notarial deeds, or tickets for artistic performances or sporting events, as the presence of a watermark limits the possibility of reproducing these by photocopying or by counterfeiting, and offers a means of recognition and/or authentication of this paper. Watermarked papers are also used in the field of customized business paper, presenting the logo, name or trademark of the business in the form of a watermark. These watermarked papers may be required in very small production lots and/or with very short production deadlines.

Differing means of producing watermarked papers are known depending on whether real watermarks or "pseudo-watermarks" are produced. At the present time, various methods have been proposed with a view to producing watermarked papers which can be classed into two categories.

1 - "Real" watermarks are produced when the sheet of paper is made, in the wet section of the papermaking machine, by cylinder molds having imprints or embossing which is indented and/or in relief or by means of watermarked rolls which have embossing that is indented and/or in relief associated with a Fourdrinier wire part (Fourdrinier machine). By these means, a pattern is produced which has light areas, when the sheet of paper is observed in transmitted light, if the imprints are in relief; or dark or shaded areas, if the imprints are indented. The light areas are due fact that the thickness of the sheet and the quantity of fibers (weight per surface unit) are lower in the areas corresponding to the imprints than in the rest of the sheet of paper. Conversely, the dark areas are due to the fact that the thickness of the sheet and the quantity of fibers is greater in the areas corresponding to the imprints.

These wet-section watermarking procedures require specific and burdensome production means for a each type of watermark, such as watermarked rolls which are produced by engraving a watermarked pattern, and cannot therefore offer the flexibility required from an economic point of view, which is also demanded by those ordering a personalized watermark for production of watermarked paper in small quantities.

2 - Production of "pseudo-watermarks" by penetration or printing of the paper with a composition which works either by rendering the fibrous mat of the sheet of paper transparent in a permanent manner, or by applying a varnish to the surface, in specific areas of the paper, are known. These procedures significantly alter the properties of the surface of the paper treated in this manner, and in particular the printability thereof.

WO 97/17493 describes coated papers with pseudo-watermarks resulting from a variation in the weight of the coating applied in specific areas, which results in a variation in the thickness and the opacity of these areas, where the weight of the coating is reduced or increased.

An object of the present invention is to provide an uncoated paper comprising pseudo-watermarks consisting of marks which locally modify the physical characteristics of the

paper such as the mass volume thereof by affecting certain properties such as the thickness thereof and, possibly, the opacity thereof.

Another object of the present invention is to provide an uncoated paper having pseudo-watermarks consisting of marks which create a tint contrast with the rest of the sheet of paper.

Another object of the present invention is to provide an uncoated paper comprising pseudo-watermarks produced without the application of a varnish to the surface thereof, in such a manner that the composition of the paper in the areas comprising the pseudo-watermark is not significantly changed.

Another object of the present invention is to provide an uncoated paper having pseudo-watermarks, whose the properties in use, and in particular the properties of printability of those areas of the surface of the paper corresponding to these marks, are not significantly altered with respect to other areas of the paper that are not marked with this pseudo-watermark.

Another object of the present invention is to provide an uncoated paper having pseudo-watermarks, which can be produced in variable quantities and small quantities under conditions which are economical as compared with the methods of the prior art, and which can be produced at widths and in quantities which are independent of the characteristics of the paper making machine, in particular, by means of a method wherein the use of these machines does not change the papermaking operations themselves.

Another object of the present invention is to provide an uncoated paper having a pseudo-watermark wherein this watermark is produced after the final production operation; that is to say upon leaving the dryer section, and possibly on the finished paper, that is to say off the production line.

In order to do this, the present invention provides an uncoated paper comprising at least one mark resembling a watermark, characterized in that a specific area, or specific areas, of the paper have a reduced thickness with respect to the rest of the uncoated paper, the weight per surface unit in this area, or these areas, of the paper being identical to that of the rest of the paper. In particular, the weight is the same in the area, or areas, and in the rest of the paper, given that variations in weight which may result from the presence of a non-evaporated additive from the rewetting solution is not significant.

In one mode of embodiment, the said area(s) present a reduced opacity, with respect to the rest of the paper.

According to a variant embodiment, the said area(s) present a color, particularly a tint and/or a luminosity, which differs from that of the rest of the paper.

In the papers according to the object of the present invention, the paper may have reduced thickness and opacity in the said area(s), with respect to the rest of the paper.

According to the present invention, the paper may have in the said area(s), agents chosen from amongst dyes, fluorescent agents, fluorescence-inhibiting agents, and agents allowing for recognition or verification. These agents can be deposited by incorporating them in a rewetting solution, described hereafter, which contains these, and can remain after evaporation of the solution. Anti-counterfeiting agents or authentication agents are well known to those skilled in the art of fiduciary papers and security papers.

According to the invention, the paper may comprise two or more fiber webs. According to a variant, only one of the surface webs has a reduced thickness and/or a difference in tint and/or luminosity in the said area(s), with respect to the rest of the multi-web paper.

According to the invention, the paper may comprise two or more laminated sheets of paper. According to a variant, the laminating adhesive is colored. In one mode of

embodiment, only one sheet of laminated paper has a reduced thickness and/or a difference in tint and/or a difference in luminosity in the said area(s) with respect to the rest of the laminated paper.

The present invention also provides a method of manufacturing an uncoated paper having at least one mark resembling a watermark as described above, characterized in that this mark is produced after the paper-drying step, or particularly, off the production line, by performing steps wherein :

a) a rewetting solution is applied to at least one side of an uncoated paper in specific area(s), then,

b) pressure and heat are applied to the rewetted said area(s) of the uncoated paper, so as to evaporate this solution and increase the density of the uncoated paper in the said area(s) with respect to the rest of the paper.

According to the present invention, "uncoated paper" refers to paper which is not covered with a pigmented coating comprising at least fine mineral pigments, particularly kaolin and/or calcium carbonate, and at least a binder or adhesive, particularly starch or latex; as well as, possibly, any additive normally used by those skilled in the art, the function of which being to improve the rheological properties of the slip and to give particular properties to the layer.

Conversely, the paper may be impregnated or surface treated with a non-pigmented composition, such as a sizing composition, particularly so as to improve the printability thereof and/or the mechanical resistance thereof, and/or the anti-soiling resistance thereof, and/or the bactericidal properties thereof.

According to the present invention, "rewetted paper" refers to paper wherein the rewetting solution has penetrated to the interior of the paper and has not yet evaporated, in the said area(s).

According to the present invention, pressure is applied to the entire uncoated paper sheet, or only to the said area(s), and the temperature of the paper is increased, so as to evaporate the rewetting solution and increase the density of the paper in the said area(s), where this solution was initially applied. The result is an increase in the specific mass of the paper in the said area(s), with respect to the rest of the sheet of paper, and more specifically, a reduction in the thickness of the paper, with an identical weight per surface unit to that of the rest of the paper. The said area(s) can therefore present a contrast in opacity (reduction in opacity) and/or a color contrast, particularly in terms of color tint and luminosity, with respect to the rest of the sheet of paper.

The opacity of the paper is in part linked to the presence of air in the gaps between the fibers and/or pigments in the paper. In the rewetting stage, the solution replaces the air in these gaps. Then in step (b), the solution is evaporated and the fibers and/or the pigments are more closely packed, thus the gaps of air take up an overall reduced volume and, notably, are less numerous than they were initially, which results in a reduction in opacity.

It should be noticed that, in a novel manner, in the method according to the invention, the increase in the paper density results from a reduction in the thickness of the treated areas with respect to the rest of the paper, the weight per surface unit remaining constant with respect to the rest of the paper. Conversely, in a "real" watermark, the weight per surface unit is lower in the light areas, because there is a smaller quantity of fibers deposited, with respect to the rest of the sheet.

In the pseudo-watermark described in WO 97/17493, the weight per surface unit is not constant, because the weight of the sheet is reduced in certain areas.

The rewetting of the paper facilitates rearrangement of the fibers and/or the pigments

during calendering. Additives may be included in the rewetting solution, which facilitate the rearrangement of the fibers and/or the pigments and/or which results in a greater or lesser penetration of the paper by this solution.

The method of the present invention can also produce a change in the color of the paper in the said area(s); this rewetting solution that comprises a colorant, particularly a tinting colorant. However in the case of a multi-web paper, and particularly a two-web paper, the color contrast in the said area(s) can also result from changes in the opacity of one of the surface webs, if there is a difference in the initial tints of this surface web and the web associated therewith.

The method according to the present invention can be used with all uncoated papers, white or colored, with no limitations as to weight; and these may be laminated or may comprise multiple webs.

In a preferred embodiment, at step (b), the pressure and the heat are applied by calendering the paper.

The calendering rolls may be heated but, in any case, the friction produced by the calendering results in heat.

The calendering operation in the present invention is performed with calenders known to those skilled in the art.

In general, the calenders can be supercalenders, soft calenders (also known as elastic) or smooth calenders. These calenders comprise a plurality of rolls, and the number thereof, as well as the type of materials from which they are made, vary according to the intended purpose, and the paper which is processed. The purpose is to flatten the surfaces of the papers by way of a greater or lesser compression of the sheet between the rolls, and by way of the greater or lesser area of contact between the rolls and the sheet, so as to give the sheets a certain "smoothness," as well as a certain softness to the touch, as well as good suitability for writing and printing. The protrusions and reliefs all are flattened to a greater or lesser degree when they pass between the rolls, and the density of the sheet is increased. The object of calendering may also be to make the surfaces glossy or matte.

The calendering rolls are chill cast, or are made of steel, and some of these may be covered in fabric, in cardboard, or in a plastic material, for example, so as to form elastic rolls. The supercalender, which comprises many rolls (in the range of 12 or more) is often located outside the machine because of maintenance, changing of rolls, and breakings of the sheet. The soft calender can be located in the papermaking machine, the number of rolls is lower, and some of these are elastic. The smoothing roll is located in the machine and comprises several rolls which are commonly made of steel, and are not covered.

The linear pressure exercised on the paper between the rolls is in the order of 0.5 to 5000 kN/cm. The temperature of the rolls when they are heated may be between 50 and 300°C.

According to the present invention, the various calendering parameters for a given piece of equipment, such as the temperature, the hardness of the rolls, any coverings for the rolls, the size of the contact area between the rolls and the sheet, and the pressure, are chosen in function of the final contrast desired. These various parameters are adapted as a function of the speed of calendering, which is itself determined by the speed at which the rewetting solution is applied. Preferably, a calender having two to six rolls, which may, if necessary, be covered in plastic (in order to render them impermeable to the rewetting solution) is used.

According to the present invention, the mark may correspond to the said area(s) and may constitute a particular pattern which appears positive, in contrast to the rest of the uncoated paper. Conversely, the particular pattern can appear negative in contrast, in so much as the mark corresponds to said rest of the sheet of untreated paper, that is to say, which was not rewetted initially. In particular the said area(s) can define a visual pattern when observed in transmitted light, resulting from a reduction in the opacity in the said area(s). The said area(s) can also define a visual pattern when observed in reflected light, resulting from a difference in color in the said area(s).

Preferably, this mark corresponds to the said treated areas. Preferably, in order to satisfy the object relating to volume, for the custom-made market, the step (a) is performed on the paper off the production line, that is to say, on the finished paper.

In the step a) the rewetting solution according to the invention can be applied by means of a photogravure device comprising a photogravure cylinder, wherein the imprints or concave indentations have form, allowing the rewetting solution to be applied according to a pattern corresponding to the mark in the said area(s).

Preferably, the rewetting solution is applied by means of a device of the type used in inkjet printing methods, particularly methods of inkjet printing on reels, wherein this ink is replaced by the aqueous rewetting solution. Inkjet printing devices, and particularly digital inkjet printing devices, allow for the production of marks according to a variety of patterns, which can be replaced quickly, and at low production costs, by other ones.

This rewetting solution can advantageously comprise a wetting agent, so as to improve or accelerate the penetration of paper by the solution. This wetting agent may be particularly advantageous, depending on the characteristics of the paper and, notably, the porosity thereof and whether or not this contains a wetting agent; and also depending on the quantity of the rewetting solution applied. By way of example, a quantity from 2 to 20 $g/m^2$ of wetting solution can be applied.

Advantageously, the wetting solution is a solution of a hydrophilic polar solvent. In particular, ethanol or 2-pyrrolidone can be used as the wetting agent.

Preferably, the rewetting solution is an aqueous solution, the use of a non-aqueous solvent results in increased costs and pollution risks.

According to a particular embodiment, a hydroalcoholic solution can be used as the wetting solution.

More specifically, an aqueous solution containing 1 to 10% by volume of ethanol, and particularly 2%, in water, or an aqueous solution containing 1 to 10% by weight of 2-pyrrolidone, and particularly 2%, in water, can be used.

In certain cases, it may be possible to use water without a wetting agent as the aqueous rewetting solution, particularly in the case of a very porous paper and/or which having a composition comprising wetting agents and/or specific pigments having a large water absorption capacity, such as certain silicas.

It is possible that the rewetting solution comprise additives such as colorants, particularly tinting colorants, fluorescent whitening agents (optical whiteners) or conversely fluorescence-inhibiting agents, and any additive used for the purposes of recognition or authentication of so-called security papers known to those skilled in the art. In particular, the wetting solution may comprise an anti-counterfeiting agent or a non-colored authentication agent which can be detected by reaction with a specific reagent or under particular conditions.

Other characteristics and advantages of the present invention will become clearer in the examples of embodiment which follow.

GENERAL CONDITIONS FOR THE PRODUCTION OF THE PSEUDO-WATERMARK OF EXAMPLES 1 to 11:

To simulate digital inkjet printing systems, a Hewlett Placard DeskJet 560 C office printer fitted with cartridge No. 51626 which had, beforehand, been emptied of ink, washed, and then refilled with a rewetting solution comprising distilled water and 2% by volume of ethanol, was used in order to rewet the following papers. In these examples, the marks are positive, unless otherwise specified, and the amount of rewetting solution provided, for is approximately 12 g/m$^2$ for an area rewetted at a resolution of 600 x 300 points per inch, raster conditions known as "coarse grain", a quality known as "courier", and a density setting known as "normal".

Papers rewetted in this manner were passed through at as laboratory calender having two rolls heated to 250°C, at a linear pressure of 3.0 kN/cm.

EXAMPLE 1: OPACITY CONTRAST

Using an A4 size, uncoated 80 g/m$^2$ sheet of white paper, sold under the trademark of RG® by GUERIMAND S.A., using PowerPoint® software by Microsoft, a pattern of a person holding a closed umbrella was reproduced by way of rewetting and calendering according to the conditions described above. The result was a paper having marks based on this pattern, similar to a darkened translucent watermark. The variable reduction in thickness in the treated area can be as much as 40% with respect to the rest of the paper.

EXAMPLE 2: OPACITY CONTRAST

Using an A4 size, uncoated 80 g/m$^2$ sheet of white paper, sold under the trademark of RG® by GUERIMAND S.A., using PowerPoint® software by Microsoft, a marbled pattern was reproduced by way of rewetting and calendering according to the conditions described above. The result was a paper having marks based on this pattern, similar to a darkened translucent watermark. The variable reduction in thickness in the treated area can be as much as 40% with respect to the rest of the paper.

EXAMPLE 3: OPACITY CONTRAST AND COLOR DIFFERENCE (TINT AND LUMINOSITY)

Using an A4 size, uncoated 80 g/m$^2$ sheet of white paper, sold under the trademark of POPSET® by ARJO WIGGINS S.A., using PowerPoint® software by Microsoft, a pattern of a person holding a closed umbrella was reproduced by way of rewetting and calendering according to the conditions described above. The result was a paper having marks based on this pattern, similar to a darkened translucent watermark. The difference in color $\Delta E^*$ (according to the colorimetric coordinates of the CIELAB system, 1976) is 5.97. The variable reduction in thickness in the treated area can be as much as 40% with respect to the rest of the paper.

EXAMPLE 4:

According to the general conditions described above, a pattern based on an identity photograph of a person was reproduced in two different places on a 115 g/m$^2$ sample of white satin, and therefore already calendered paper, however for one of the reproductions (a), the dark portions of the photograph were reproduced by rewetting, and for the other reproduction (b), the light portions of the photograph were reproduced by rewetting, and

thus appeared in negative. After calendering and drying, the paper produced in this manner is a security paper personalized by the double pseudo-watermark of the recognizable identity photograph.

By direct observation of reflected light, (a) can be observed as tinting contrasts.

By observation of transmitted light, (b) can be observed in the form of opacity contrast (the rewetted areas become less opaque and therefore lighter), where, conversely, (a), in transmitted light, and (b), in direct observation of reflected light, are both perceived as a negative images of the identity photograph.

EXAMPLE 5:

A hand-sheet of an uncoated two plies paper sheet of 170 g/m$^2$ was made. One of the webs is white in color and has a weight of 90 g/m$^2$ and the other web is a green tinted and has a weight of 80 g/m$^2$.

After drying the two plies paper, the pattern of a person holding a closed umbrella in his hand was reproduced on the white web side, by rewetting and calendering according to the general conditions described above, using PowerPoint® software made by Microsoft. The result was a paper which had marks based on this pattern, which appeared by way of transmitted light and resembled a translucent and tinted shaded watermark. By direct observation of reflected light, the pattern can be seen, as a result of the green tint of the web beneath the pattern. As the white web was quite thick, the rewetting solution did not penetrate into the green web.

EXAMPLE 6:

An uncoated laminated paper of 210 g/m$^2$ was produced by gluing two uncoated white papers of 90 g/m$^2$ using a poly (vinyl acetate) based adhesive comprising 3% by weight of a tinting colorant, the Violet BB 200%.

On one side thereof, the pattern of a person holding a closed umbrella in his hand was reproduced by rewetting and calendering according to the general conditions described above, using the PowerPoint® software by Microsoft. The result was a paper having a mark based on the pattern which, in transmitted light, resembled a translucent and tinted shaded watermark. Direct observation of reflected light allowed the image to be seen due to the tint of the lamination adhesive. The rewetting solution did not penetrate throughout the paper as a result of the adhesive.

EXAMPLES 7 AND 8: COLOR CONTRAST

Example 7:

A weight quantity of 0.01% of a tinting colorant powder, VIOLET BB 200%, was added to the water/ethanol rewetting solution described above.

Using an A4 size, uncoated 80 g/m$^2$ sheet of white paper, sold under the trademark of RG® by GUERIMAND S.A., using PowerPoint® software by Microsoft, the pattern of a person holding a closed umbrella in his hand was reproduced by way of rewetting and calendering according to the conditions described above. The result was a paper having marks based on this pattern, similar to a translucent watermark. The pattern was also observed by way of reflected light, due to purple tint thereof.

Example 8:

Only 0.005% by weight of the tinting colorant powder, VIOLET BB 200%, was added to

the water/ethanol rewetting solution described above.

A pseudo-watermark was produced as described in example 7. The result was a paper having marks based on the pattern, similar to a translucent watermark, which were more visible by way of transmitted light, as a result of the fact that the amount of color and was less than that in the case of example 7. The pattern was also observed by way of reflected light, due to violet tint thereof.

EXAMPLE 9: COLORED ANTI-COUNTERFEITING REACTION

An anti-counterfeiting colorant in the amount of 4% by weight was added to the water/ethanol rewetting solution described in the general conditions; the colorant, known as DHTD yellow, which was applied changes from transparent to yellow-brown as a result of the action of sodium hypochloride.

Using an A4 size, uncoated 80 g/m$^2$ sheet of white paper, sold under the trademark of RG® by GUERIMAND S.A., using PowerPoint® software by Microsoft, a word and a drawing were reproduced by way of rewetting and calendering according to the conditions described above. The result was a paper having uncolored marks based on the pattern, similar to a translucent watermark, visible by way of transmitted light. If sodium hypochloride (bleach) is applied thereto as a falsifying agent, it develops a yellow-brown color at the marks, which shows the falsification attempt.

EXAMPLE 10: OPACITY AND FLUORESCENCE CONTRAST

A fluorescent whitener sold under the trademark Blancophor® BSU PN in the amount of 2% was added to the water/ethanol rewetting solution described in the general conditions.

The pattern of the person holding a closed umbrella in his hand was reproduced by rewetting and calendering according to the general conditions described above on a sample of uncoated 80 g/m$^2$ vellum paper produced from fibers free of fluorescent whiteners. This resulted in a paper having uncolored marks based on the pattern, similar to a translucent watermark, which was visible in transmitted light by way of opacity, contrast and which, when observed directly by way of reflected light, is revealed to a greater or lesser extent by tint and fluorescence contrast, depending on the amount of ultraviolet radiation comprised in the natural or artificial observation incident light.

Example 11:

The rewetting solution comprises distilled water and 2% by weight of 2-pyrrolidone (purity 98%).

After calendering a paper similar to that used in example 3 at 50°C, with a linear pressure of 1.0 kN/cm, a paper was produced with a pseudo-watermark according to the invention, by way of tint and opacity contrast.

EXAMPLE 12:

Using a narrow soft-calender, SCITEX 6240 inkjet printing head was installed at one meter from the calendering rolls. The printing and calendering speeds were synchronized. A mixture of demineralized water and 5% by volume of ethanol was used as the paper rewetting solution. The calender comprised two rolls: one of these was made of steel and the counter roll was covered in plastic. These rolls were heated to 80°C, and the linear pressure between the rolls was 2.5 kN/cm. A sheet of white paper was off-wound from the roll, and a pattern was produced on the sheet with the rewetting solution by means of the

printer head; then this sheet was passed between the two calendering rolls. The feed rate for the sheet of paper was 20 m/min.

The dry sheet of paper had a thickness of 60 μm and the density in the rewetting areas was increased, resulting in a reduction in thickness of 16 μm. This resulted in a pseudo-watermarked paper according to the invention by way of reduced thickness.